

What is claimed is:

1. A process for producing a fine carbon fiber by a method of thermal decomposition of at least one organic compound containing VIB group element in the periodic table in a molecule using a ultra fine particles comprising at least one transition metal as a catalyst, wherein the production process comprises at least a raw material gas-feeding part, a carrier gas-feeding part, a reaction furnace, a fine carbon fiber-separating and collecting apparatus, a fine carbon fiber tank, a reacted gas-cooling apparatus, a second fine carbon fiber-separating and collecting apparatus and a gas-recycling apparatus, and the fine carbon fiber is collected from the reacted gas passing through the fine carbon fiber-separating and collecting apparatus and the reacted gas-cooling apparatus by the second fine carbon fiber-separating and collecting apparatus, and then a part of the reacted gas is recycled by the gas-recycling apparatus.

2. A process for producing a fine carbon fiber by a method of decomposition of at least one organic compound containing VIB group element in the periodic table in a molecule using a ultra fine particles comprising at least one transition metal as a catalyst, wherein the

production process comprises at least a raw material gas-feeding part, a carrier gas-feeding part, a reaction furnace, a fine carbon fiber-separating and collecting apparatus, a fine carbon fiber tank, a reacted gas-cooling apparatus, a second fine carbon fiber-separating and collecting apparatus, a gas-recycling apparatus, a second reacted gas-cooling apparatus, a condensate tank and a moisture separator, and the fine carbon fiber is collected from the reacted gas passing through the fine carbon fiber-separating and collecting apparatus and the reacted gas-cooling apparatus by the second fine carbon fiber-separating and collecting apparatus, and then the reacted gas is cooled by the second reacted gas-cooling apparatus to separate condensate and recycled by the gas-recycling apparatus, and further water and high boiling products are separated from the condensate by the moisture separator to recycle the unreacted raw material organic compound.

3. The process for producing a fine carbon fiber as described in claim 2, wherein the fine carbon fiber is collected from the reacted gas by the second fine carbon fiber-separating and collecting apparatus, and then a part of the reacted gas is cooled by the second reacted gas-cooling apparatus.

4. The process for producing a fine carbon fiber as described in claim 2, wherein the fine carbon fiber is collected from the reacted gas by the second fine carbon fiber-separating and collecting apparatus, and then the total amount of the reacted gas is cooled by the second reacted gas-cooling apparatus.

5. The process for producing a fine carbon fiber as described in any of claims 1 to 4, wherein 20 % or more of the reacted gas is recycled.

6. The process for producing a fine carbon fiber as described in claim 5, wherein 50 % or more of the reacted gas is recycled.

7. The process for producing a fine carbon fiber as described in any of claims 1 to 6, wherein the second reacted gas-cooling apparatus comprises a mechanism in which the reacted gas is cooled to 40°C or higher to 150°C or lower and then separated by a filter.

8. The process for producing a fine carbon fiber as described in any of claims 2 to 7, wherein the moisture separator uses at least one method of distillation,

adsorption and membrane separation.

9. The process for producing a fine carbon fiber as described in any of claims 1 to 8, wherein the fine  
5 carbon fiber has a fiber diameter of 0.1 nm or more to 1  $\mu\text{m}$  or less.

10. The process for producing a fine carbon fiber as described in any of claims 1 to 9, wherein the fine  
10 carbon fiber comprises a single-walled carbon nanotube in which a fiber diameter is at least 5 nm or less and which has an axial chiral structure.

11. The process for producing a fine carbon fiber as  
15 described in any of claims 1 to 9, wherein the fine carbon fiber comprises a multi-walled carbon nanotube in which a fiber diameter is at least 10 nm or less and which has an axial chiral structure.